Rebuilding analyses of West-Coast Pacific ocean perch

August 8, 2000

James N. Ianelli

and

James Hastie

Alaska Fisheries Science Center, NMFS

7600 Sand Point Way N.E.

Seattle, Washington 98115-6349

Summary

We extend the results from this years stock assessment to evaluate different harvest policies related to rebuilding the Pacific ocean perch (POP) resource off the coasts of Washington, Oregon, and California. We selected 6 policies projected from 2001 to 2011: no fishing, 300 tons per year, 500 tons per year, 750 tons per year, an (unadjusted) F_{msy} policy, and an adjusted (40-10) F_{msy} policy. The expected value for time to rebuild for these policies ranges from slightly before 2003 to 2004 based on stochastic projections from the posterior distribution. The probability that the stock will be above the expected value of B_{msy} by the year 2011 is relatively high (>50%) for all of these harvest levels.

1 Introduction

Stock assessments for the US west coast Pacific ocean perch (POP) are generally conducted every three years. Since the early 1980s, this stock has been considered as a primary candidate for rebuilding stock levels by directed management measures. In 1981 the Pacific Fishery Management Council (PFMC) adopted a 20-year plan to rebuild the depleted Pacific ocean perch (*Sebastes alutus*) resource in waters off the Washington and Oregon coast. In 1998, the PFMC acted on NMFS' National Standards from the re-authorized Magnuson-Stevens Fisheries Management and Conservation Act and determined that rebuilding efforts needed to be re-focused. The purpose of this report is to evaluate a rebuilding program for POP based on the recently completed assessment of Ianelli *et al.* (2000) for the PFMC's Groundfish Management Team (GMT).

2 Methods

We begin with Model 1c results from Ianelli *et al.* (2000). Model 1c from the assessment was one that the PFMC's Stock Assessment Review (STAR) Panel recommended because it included a prior distribution on the value for steepness based on Dorn's (2000) analyses. We concur with this recommendation since the other models that used a uniform prior distribution on steepness (non-informative) resulted in a seemingly unrealistic high level of probability that the stock could be fished quite hard. That is, with steepness values approaching 1.0, the target stock size becomes very small.

These results are in the form of the joint multivariate posterior distribution over 311 parameters as represented by a Markov Chain Monte Carlo (MCMC) integration run with chain length of five million. We systematically thinned the chain by selecting every 1,000th simulation so that 5,000 parameter vectors represent the final posterior distribution. This thinning process avoids possible problems with autocorrelated MCMC simulations. The MCMC algorithm can result in significantly autocorrelated chains with difficult likelihood surfaces (e.g., surfaces with sharp and/or curved ridges). Some key parameter output for this posterior distribution is depicted in Fig. 1. The projection procedure is set up to simply run from each of the 5,000 vectors representing the posterior distribution. These parameter vectors can be thought of as a proportional sample from the "true" multivariate posterior distribution. Marginal distributions are compiled for any quantity of interest by constructing frequency histograms from the 5,000 unique function evaluations (a function evaluation represents a single model evaluation including the projections under different policy alternatives). Stochastic future recruitment is based on the stock-recruitment curve (as from a given parameter draw) and the level of recruitment variability as estimated. We assumed recruitment to be log-normally distributed about the stock-recruitment curve (as determined from each parameter draw).

We selected 6 policies projected from 2001 to 2011: no fishing, 300 tons per year, 500 tons per year, 750 tons per year, an (unadjusted) F_{msy} policy, and an adjusted (40-10) F_{msy} policy. The adjusted F_{msy} policy was based on the 40-10 policy adopted by the PFMC for other stocks. Figure 2 shows how this rate is applied for different levels of stock size relative to the theoretical average unfished level of spawning biomass (B_0).

3 Results

The average catch and spawning biomass for the six different harvest scenarios are shown in Table 1. The adjusted (40-10) F_{msy} policy resulted in 1,612 tons average catch over the next 10 years and was expected to rebuild by the year 2004. The unadjusted F_{msy} policy also exceeded the B_{msy} target by the year 2004 and had an average yield of 1,876 tons. All other policies (fixed catch at 0, 300, 500, and 750 tons) indicate that rebuilding is expected to have occurred by the year 2003. These trends in expected values are also displayed in Figure 3.

The uncertainty in these spawning biomass levels given different harvest levels is quite high (Fig. 4). By the year 2011, the distribution of the spawning biomass under these harvest levels is projected to a reasonable range (between 10% and 90% probability) from 3- to 5-fold. However, for all policies except the unadjusted F_{msy} strategy, the probability that the stock will exceed the expected value of B_{msy} is greater than 50% (Table 2).

4 Discussion

These analyses indicate that rebuilding is fairly likely to occur within the next few years. Furthermore, there is considerable probability that the current level of stock size is greater than the target stock size (Ianelli *et al.* 2000). This analysis is predicated on a number of model assumptions. For example, the PFMC's STAR panel noted that a reasonable alternative should include the use of a Ricker stock-recruitment curve instead of the Beverton-Holt curve that was used. Ianelli *et al.* (2000) provides the Ricker model for comparison and found that the MSYL (the level of stock size relative to unfished where MSY occurs) is somewhat higher (~42% compared to ~33% for the Beverton-Holt case).

The use of Dorn's (2000) prior distribution on steepness influence the results presented here (when the Bayesian integration is performed). This brings up the question of whether there are more appropriate prior distributions to use. The sensitivity of the prior on the posterior mode was insignificant, but had a significant impact when the model was integrated. This type of sensitivity could be explored further. However, rationale for using an alternative prior distribution would need to be carefully developed.

5 Literature Cited

Dorn, M. 2000. Advice on West Coast rockfish harvest rates from Bayesian meta-analysis of stock-recruit relationships. Paper presented at the West Coast groundfish productivity workshop, March 20-24, 2000.

Ianelli, J.N. 2000. Simulation analyses testing the robustness of harvest rate determinations from west-coast Pacific ocean perch stock assessment data. Draft working paper submitted to the Harvest Rate Workshop, March 20-23rd, 2000, Seattle WA.

Ianelli, J.N., M. Wilkins and S. Harley. 2000. Status and future prospects for the Pacific ocean perch resource in waters off Washington and Oregon as assessed in 2000. Draft submission for: Status of the Pacific coast groundfish fishery through 2000 and recommended acceptable biological catches for 2001. Pacific Fishery Management Council, Portland, OR.

6 Tables

Table 1. Average catch (tons) and spawning biomass (tons of mature female POP) for the different projection options. The expected value for B_{msy} is estimated 16,250 tons of mature female spawning biomass. NOTE: these values represent integrated "expected values" from Model 1c (Ianelli *et al.* 2000) and are different from the "modal values" presented in the assessment.

Year	$F=0$	300 t/yr	500 t/yr	750 t/yr	F_{msy} 40-10	F_{msy} *Unadj.*
			Catch			
2001	0	300	500	750	1,377	1,853
2002	0	300	500	750	1,494	1,906
2003	0	300	500	750	1,620	1,935
2004	0	300	500	750	1,664	1,919
2005	0	300	500	750	1,670	1,900
2006	0	300	500	750	1,664	1,883
2007	0	300	500	750	1,656	1,868
2008	0	300	500	750	1,650	1,856
2009	0	300	500	750	1,647	1,846
2010	0	300	500	750	1,645	1,838
2011	0	300	500	750	1,644	1,830
			Spawning Biomass			
2001	14,410	14,410	14,410	14,410	14,410	14,410
2002	15,792	15,651	15,556	15,439	15,143	14,919
2003	17,608	17,318	17,124	16,883	16,219	15,789
2004	19,089	18,647	18,353	17,985	16,881	16,290
2005	20,172	19,582	19,189	18,698	17,139	16,420
2006	21,034	20,301	19,813	19,204	17,197	16,372
2007	21,784	20,915	20,336	19,612	17,177	16,255
2008	22,482	21,482	20,816	19,983	17,138	16,128
2009	23,145	22,020	21,269	20,331	17,096	16,004
2010	23,787	22,540	21,709	20,669	17,060	15,890
2011	24,419	23,054	22,143	21,004	17,038	15,790

Table 2. Probability that the stock size will exceed the expected value of B_{msy} in the year 2011 for the different harvest levels.

Year	$F = 0$	300 t/yr	500 t/yr	750 t/yr	F_{msy} 40-10	F_{msy} *Unadj.*
2011	84.2%	79.9%	77.0%	69.9%	54.5%	40.7%

7 Figures

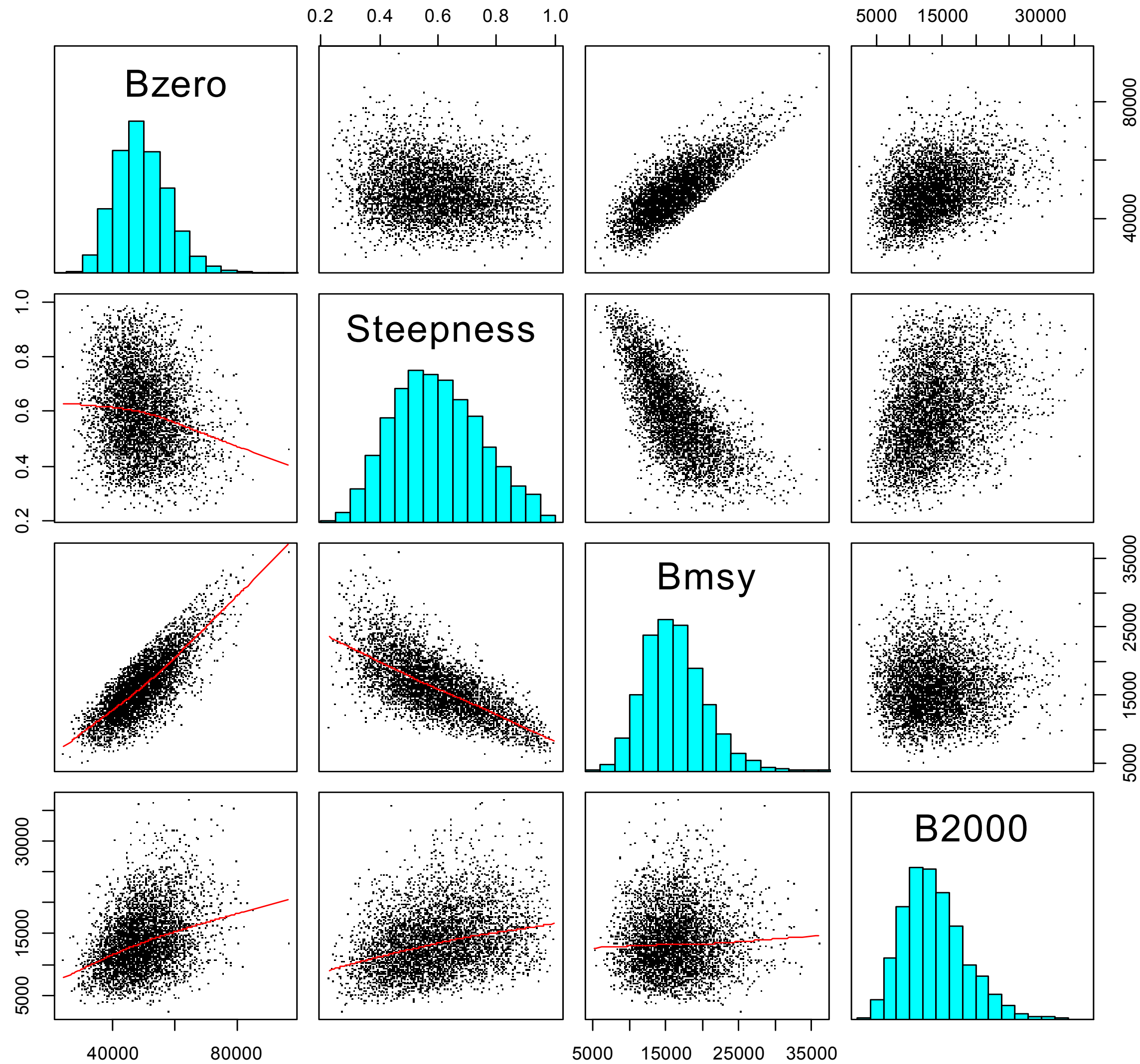

Figure 1. Pair-wise scatter among key model variables from Ianelli *et al.* 2000 Model 1c with marginal probabilities plotted in the diagonal frames.

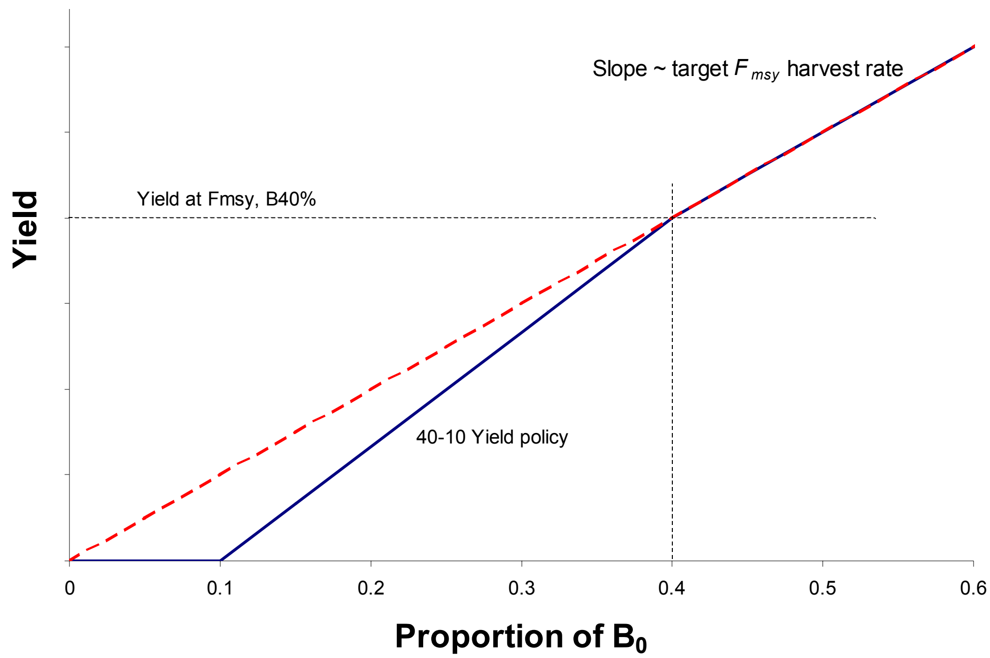

Figure 2. The 40-10 adjustment applied to the F_{msy} yield level relative to the estimate of B_0.

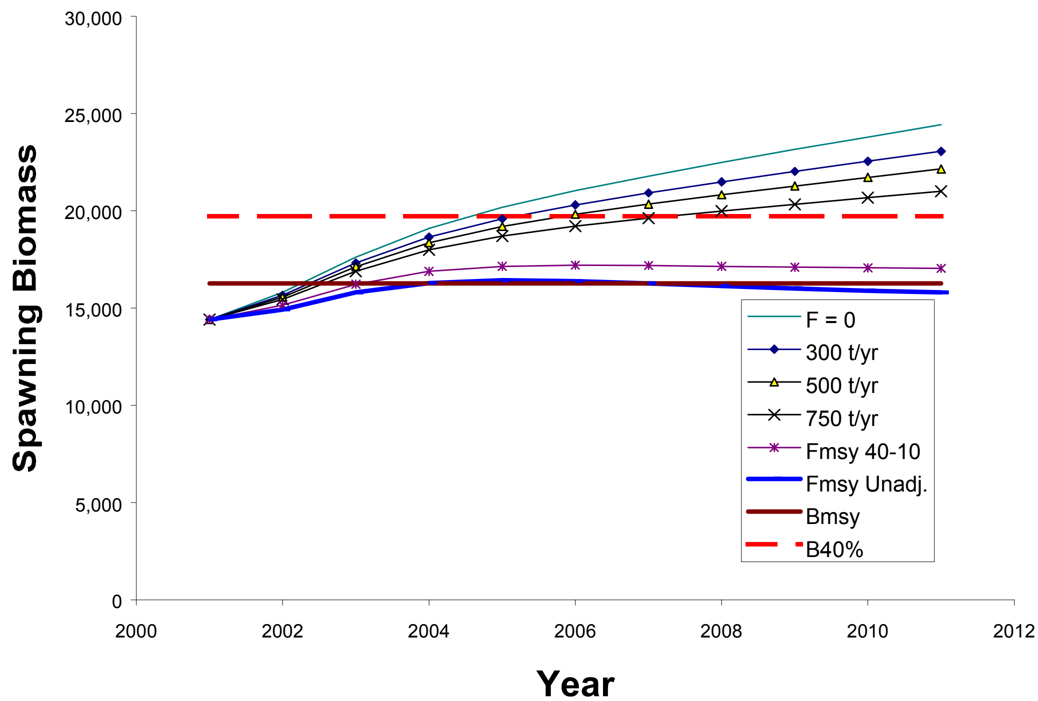

Figure 3. Expected values of spawning biomass trajectories under different future harvest policies relative to the B_{msy} level and 40% of B_0.

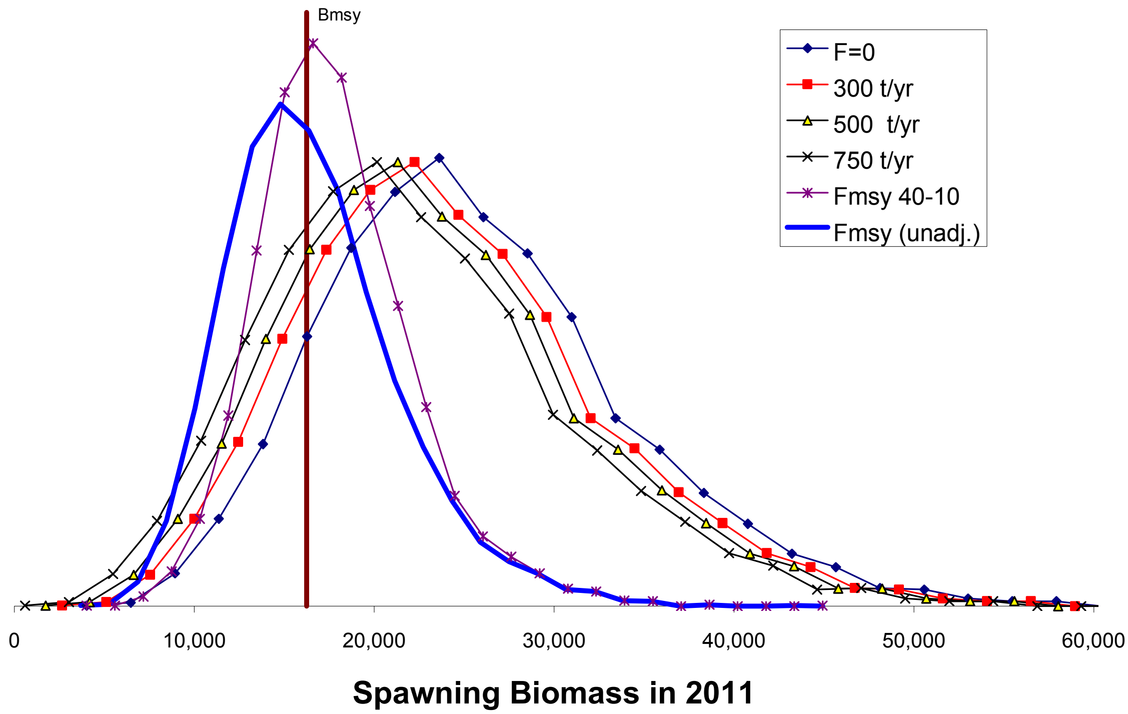

Figure 4. Probability distributions of projected POP female spawning biomass in the year 2011 under different harvest levels, and under adjusted (40-10) F_{msy} harvest rates. The vertical line represents the expected value for B_{msy}.